DOCUMENT RESUME

ED 270 063 HE 019 378

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TITLE Instructional Costs per Student Credit Hour: Differences by Level of Instruction.
INSTITUTION National Center for Higher Education Management Systems, Boulder, Colo.
PUB DATE 30 Nov 85
NOTE 33p.
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *College Instruction; *College Programs; Educational Finance; Graduate Study; Higher Education; *Institutional Characteristics; *Intellectual Disciplines; Undergraduate Study; *Unit Costs; Upper Division Colleges

ABSTRACT

Direct costs of college instruction were assessed by type of institution and type of instructional program (i.e., by discipline). Determining direct costs by level of instruction involves allocation procedures focusing on faculty time. Central tendencies were derived from the results of a large number of studies. Data sources included reports of state coordinating or governing boards, institutional research studies and dissertation research, and studies conducted by the National Center for Higher Education Management Systems. There are systematic differences in cost ratios per credit hour by type of institution (i.e., baccalaureate, comprehensive, doctoral, research, and doctoral and research). With a few exceptions, the larger and more complex the institution, the larger the cost ratios. In considering differences by discipline and institution, comprehensive institutions had relatively high cost ratios in the sciences, both national and social. This occurred when comparing upper- to lower-division levels as well as masters to lower division. Very low costs at the lower-division level for mathematics and the social sciences, and relatively high costs at the upper-division level for the laboratory-oriented sciences, were found at both doctoral and comprehensive institutions. Six pages of references conclude the report. (SW)

Instructional Costs per Student Credit Hour: Differences by Level of Instruction

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November 30, 1985

Cost by Level

The variation of unit costs by level of instruction, on either a per student or per student credit hour basis, is a traditional issue in the economics and finance of higher education. Funding formulas, for either requesting or allocating funds, often include recognition of an institution's effort by level of instruction. The same is likely to be true for internal budgeting among departments and programs, and for many kinds of program planning. In recent times, the growing interest in differential pricing schemes, in which tuition is established on the basis of the different costs of programs (or courses) taken by students, has added another reason for higher-education administrators to be cognizant of cost differences associated with levels of instruction. Occasionally, researchers have examined these costs in terms of an equity framework (for example, James, 1978), from the perspective of analyzing productivity in higher education (as in O'Neill, 1971; Radner and Miller, 1975; Skoro and Hrvyniak, 1979), or from the perspective of analyzing the university as a firm (for example, Southwick, 1967; Verry and Davies, 1976). Finally, as the authors of Involvement in Learning have emphasized (Study Group on the Conditions of Excellence in American Higher Education, 1984), costs by level are one indication of whether too few resources may be flowing to the early (lower-division) years of the collegiate experience, thereby exacerbating problems such as high attrition rates and inadequate preparation in basic knowledge and skills.

The determination of costs by level of instruction is sufficiently complex so that such data are not routinely gathered by all, or even most, institutions. Thus, while such data are important, they are not as available as they ought to be. Furthermore, when such data are gathered only locally,

they are subject to the vagaries of all cost data, and they may reflect local idiosyncrasies more than general, underlying tendencies with broad applicability.

The objective of this study, then, is to provide data about costs by level of instruction in such a way as to be useful for the many purposes mentioned at the outset. The results of a large number of cost studies that have calculated costs by level will be used to determine what the ratios are, on average, between the unit costs of providing instruction at the lower-division versus upper-division versus graduate level (distinguishing when possible between masters and doctoral work).

The investigation will focus primarily on the direct costs of instruction, as opposed to costs, such as those for general administration, student services, the physical plant, and so on, which have only an indirect relationship to instruction and levels thereof. Nonetheless, data on full costs will be provided in instances where they are available. The results to be presented will be disaggregated by type of institution and by type of instructional program (i.e., by discipline). All of the results reported in tables are based on data derived from cost accounting procedures.

Production Issues

Several types of institutional resources contribute to the provision of instructional services: personnel, supplies and equipment, classroom and laboratory space, libraries, communication (e.g., printing, telephone), and travel. The largest single component of the direct cost of instruction is faculty compensation (salaries and fringe benefits). It is not uncommon for this cost component to constitute 70 to 80 percent or more of total direct

instructional expenditures. The other cost components tend to follow faculty costs. For example, the greater the number of faculty, the higher the cost for telephones, supplies, travel, and so on. Accordingly, a major issue in any study of costs by level of instruction is how to allocate faculty compensation across the levels. This issue will be discussed in the next section.

The data we will examine presently will show the extent to which costs on a per student credit hour basis are less for lower-division than for upper-division or graduate instruction. The reasons why this is so are straightforward. On average, the student-faculty ratio is higher at the lower-division level. Also, proportionately more junior faculty (assistant and instructor ranks, teaching assistants) are used in lower-division courses, leaving a disproportionate number of senior faculty, with their higher salaries, to teach at the upper-division and graduate levels. In addition, it appears that more supplies and equipment are used on a per-credit-hour basis at the higher instructional levels.

Differences in available resources by type of institution, resource prices, and resource utilization lead to differences in the cost ratios between levels of instruction. For instance, institutions that provide doctoral-level instruction will be able, if they so choose, to use their doctoral students as instructors at the lower-division level. Since the pay rates for these individuals are relatively low, the relative cost for lower-division instruction is likely to be less at doctoral institutions than at four-year institutions that must rely more heavily on regular faculty. Of course, the presence of part-time faculty (who are not graduate students) in virtually all types of institutions adds complexity to the situation and makes it more difficult to predict the outcome by type of institution.

Scale-related effects also add complexity to the underlying phenomenon. As a rule, the smaller scale of operation (that is, the lower the enrollment), the higher the costs per credit hour or per student, and vice versa. Thus, institutions that provide services at the graduate level to small numbers of students may have exceptionally high cost ratios, comparing graduate to lower-division instruction. Similarly, institutions that have small upper-division enrollments, perhaps due to high attrition rates, are likely to experience high cost ratios comparing upper to lower-division instruction. Institutions that can maintain large class sizes can keep their unit costs relatively low at any level of instruction. Scale-related effects can be especially strong at the program, or discipline, level of analysis, where extremely small enrollments sometimes occur. Gibson (1968) analyzes these effects for average costs by discipline by level of instruction, and Brinkman (1981) does the same for marginal costs by institution by level of student.

Allocation Issues

As noted earlier, determining direct costs by level of instruction inevitably involves allocation procedures focusing on faculty time. Essentially two allocation procedures, or variations thereof, are used. The simplest procedure is to base the allocation of faculty costs on faculty teaching assignments. For example, if a faculty member teaches one-third of his or her courses at the lower-division level, then one-third of that individual's compensation (salary plus fringe benefits) for instruction would be allocated to the costs of lower division.

The other procedure is more complicated, as it attempts to take into account both the intensity of faculty effort (for example, how much time they actually spend preparing for a course) and the full range of faculty activities

(for example, lecturing in a classroom, conducting seminars, advising majors, directing dissertations, serving on committtees, and so on). With respect to effort, more preparat on may be required for an upper-division course than for a course at the lower-division level. If so, then more faculty compensation would be allocated to upper-division costs than would be called for by basing the allocation on course assignments alone. Typically, this more complex procedure is based on a faculty activity survey wherein faculty are asked to indicate how much time they spend on each of their duties. Of the 225 data points in the core analysis, to be reported on below, roughly 80 percent are based on a faculty assignment procedure, 14 percent on a faculty activity survey, and 6 percent on procedures not disclosed. Preliminary analysis revealed that distinguishing between the allocation approaches had no material effect on the results, so the results reported below are not disaggregated on this dimension.

A thorough analysis of how faculty costs can and should be allocated, with respect to determining the cost of a course, can be found in Crothers (1973). He concludes that the true costs of instruction can be determined only by means of a faculty analysis survey--he found, for instance, that about 45 percent of a faculty member's time was spent on non-instructional activities. Fortunately, in light of the available data, the critical issue for the present study is not the true cost of instruction, but the relative costs by level. Crothers' finding that there is little correlation between course level and faculty time spent on the course lends credibility to allocating faculty costs by course assignment. The tendency of senior faculty to devote somewhat more of their time to non-instructional activities will tend to bias upwards the relative costs of upper-division and graduate instruction when costs are allocated solely on the basis of teaching assignment.

Other direct instructional expenditures, such as office supplies, telephone, and travel that cannot be directly associated with particular courses typically are allocated to levels of instruction on the basis of faculty assignment or effort by level. The same is apparently true for allocating the cost of support staff, although frequently one can only guess how these costs were actually distributed.

As noted earlier, studies will occasionally include data on full costs (direct plus indirect). Various procedures can be used to allocate indirect costs, such as expenditures for general administration, student services, the library, and the operation of the plant, to the instructional function, and then, within that function, to levels of instruction (a useful discussion can be found in NACUBO-NCHEMS, 1977). Variations in procedures will be ignored in reporting full cost figures below. There are relatively few data points as it is, without further disaggregation. Furthermore, examination of the full-cost data shows that they move quite consistently with direct-cost data, indicating that they probably have not been materially affected by differences in allocation procedures.

Study Method

The study being reported on here is a research synthesis, or secondary analysis. The aim of the study is to derive central tendencies from the results of a large number of studies. The main advantage of this approach is that it overcomes a problem that plagues virtually any primary analysis of costs, which is the vulnerability of any one set of cost data to local idiosyncrasies. Such idiosyncrasies can be the result of pecularities in accounting, in the actual structure of the processes being analyzed, or in critical aspects of the environment surrounding the process (such as the

availability of a particularly large or small amount of revenue per unit of activity). In the latter two cases, the costs may be correctly stated, but they will not be representative of the typical institution's experience. By contrast, examining and integrating the findings of many studies leads to results that can serve as benchmarks against which a given institution or system of institutions can evaluate its own costs.

The mode of synthesis followed here is in the spirit of the meta-analytic approach as developed in Glass, McGaw, and Smith (1981), Hunter, Schmidt, and Jackson (1982), and others. In essence, this means that an effort has been made to include data from a very wide set of studies, to standardize the data from these studies to the extent possible, and to integrate and present the standardized data using conventional statistics (as opposed to reporting the results in the serial fashion of the typical literature review).

There are three primary sources of data on costs by level of instruction. One source consists of the reports of state coordinating or governing boards that require data of this sort from the institutions within their purview. Examples of states that produce such reports include Florida, Kansas, Idaho, Illinois, Minnesota, Mississippi, Oregon, Tennessee, Virginia, and Wisconsin. The reports from a state, such as Kansas, that depends heavily on benchmark data from institutions outside the state can be an especially good source of data (i.e., it will contain many data points generated in a consistent manner). Higher-education agencies in states that do not produce periodic reports of this kind may have pertinent data available from onetime special studies (as is true for Kentucky and Washington, for instance). And still other states, such as Ohio and Louisiana, can provide formula funding factors that either generate or are based on costs by level of instruction.

A second source of data consists of various studies conducted by individuals working on dissertations or engaged in research as staff members of an institution or system office. Some system offices, such as the one for the University of Colorado, have these studies done annually. A third source of data is a set of studies conducted by the National Center for Higher Education Management Systems (NCHEMS) during the early 1970s. These studies, of which 3) could be used in the present investigation, were part of an effort to develop costing and interinstitutional data sharing models. These studies are especially valuable for comparative purposes because they employed a consistent methodology.

A particular report or study may provide data by discipline, by groups of disciplines, by institution, or by groups of institutions. The NCHEMS studies, in addition to providing data by discipline, also provide data by student major (that is, cost data based on actual course-taking patterns of students with various majors). Altogether, the data that could be found make it possible to report results by institutional type, aggregated by institution and by discipline.

Organizing data by institutional type and by discipline were only two of a number of steps taken to standardize the available data. As mentioned in the previous section, some studies provide data on direct costs, some on full costs, and some on both. Direct cost results are reported separately from full cost results in what follows. A few studies provide data by level of student. They were not used. All results reported here refer to costs by level of instruction. Similarly, some studies report costs on a per-student basis, but most report costs on a per-credit-hour basis. This difference is not important when comparing lower-division to upper-division, because the typical

credit-hour load tends to be roughly the same at the two levels. However, the course load of a typical graduate student is usually less than that of the typical undergraduate. Thus cost ratios between graduate and lower-division will be higher, on average, when reported on the basis of credit hours than on the basis of full-time equivalent students. All of the cost ratios reported in the tables below are based on per-credit-hour costs.

Data from 15 cost accounting studies were not included in deriving the results shown below. The primary reasons for excluding these data are as follows: the type of institution represented by the data could not be determined, the type of cost (direct versus full) could not be determined, the data were too old (pre 1950), or the data had to do with a subset of an institution (such as a college within a university) that did not correspond with the structure adopted for reporting on disciplines. In addition, data from several studies, for example, Southwick (1969) and Brinkman (1981), which report results based on statistical estimates, rather than cost accounting procedures, were not used in developing the tabled material. The data in these studies are cost ratios by level of student rather than by level of instruction.

Results by Institution

In classic cost and productivity studies that depend on ratios of costs by level, as in O'Neill (1972) and Bowen (1980), it has been customary to assume that the same ratios would hold for any type of institution. Yet, reflecting on the underlying mechanisms (differences in class size, the presence or absence of teaching assistants, a research emphasis that might drive up the salaries of certain faculty, and so on), one might well conclude that the cost ratios ought to vary by institutional type. Specifically, it would be reasonable to expect

that the larger, more complex institutions (in terms of degree levels and emphasis on research) would experience greater differences in costs by level. This turns out to be the case.

As shown in Table 1, there are systematic differences in the cost ratios by type of institution. (The institutional classification is explained in Appendix A.) The differences are quite modest comparing upper to lower division, but more substantial comparing graduate to lower division. With a few exceptions, the larger and more complex the institution, the larger the cost ratios. One exception is the high figure for G2:L at doctoral institutions compared to that at research universities. This is likely the result of extreme diseconomies of scale in some of the programs at the doctoral institutions. As the ranges indicate, there are considerable variations from one institution to another within institutional types. A variety of unique circumstances are the reason, no doubt, and they need to be kept in mind, as in any cost study, in thinking of the normative value of these data.

As the results indicate, the full-cost ratios without exception are less than the direct-cost ratios. This is to be expected, because most of an institution's indirect costs have little if anything to do with levels of instruction. Thus, with respect to the unit costs of instruction, they tend to be distributed (allocated) relatively evenly across the levels, thereby diminishing the cost ratios.

How do these results compare to figures used in the classic studies mentioned above, wherein cost ratios by level are an integral part of various kinds of cost and productivity analyses? The answer is surprisingly complicated. If we turn first to O'Neill's (1971) longitudinal analysis of productivity in higher education, we find the following cost ratios being used:

Table 1. Cost Ratios per Credit Hour by Level of Instruction

	Direct Costs					Full Costs			
	U:L	G1:L	G:L	G2:L		U:L	G1:L	G:L	G2:L
A. Baccalaureate									
Min	1.06	1.30				1.10	1.30		
Max	2.62	3.00				1.89	2.80		
Mean	1.60	1.92				1.49	1.94		
S.D.	0.39	0.52				0.28	0.55		
Cases	29	7				15	5		
B. Comprehensive									
Min	1.20	1.26		3.69		1.20			2.05
Max	2.28	6.10		5.23		1.70	5.90		4.19
Mean	1.57	2.80		4.46		1.39	2.59		2.99
S.D.	0.21	0.79		0.60		0.14	1.11		0.81
Cases	80	80		4		20	20		4
C. Doctoral									
Min	1.18	2.63	2.23	3.67		1.16	2.84	2.00	3.23
Max	2.00	4.63	6.25	13.40		1.90	4.71	5.83	6.45
Mean	1.64	3.79	4.54	9.12	194	1.54	3.30	4.07	4.46
S.D.	0.19	0.45	1.20	2.92		0.14	0.58	1.66	1.04
Cases	25	19	12	13		7	8	6	8
D. Research									
Min	1.28	2.81	2.94	3.48		1.47	2.58	2.91	3.84
Max	2.23	4.93	7.16	11.26		2.00	3.08	5.10	4.71
Mean	1.83	3.87	4.97	8.45		1.74	2.83	4.11	4.28
S.D.	0.23	0.73	1.09	2.30		0.15	0.25	0.68	0.43
Cases	46	24	22	24		8	2	6	2
E. Doctoral & Research									
Min	1.18	2.63	2.23	3.48		1.16	2.58	2.00	3.23
Max	2.23	4.93	7.16	13.40		2.00	4.71	5.83	6.45
Mean	1.76	3.61	4.78	8.56	189	1.61	3.21	4.08	4.42
S.D.	0.24	0.69	1.16	2.54		0.22	0.56	1.27	0.95
Cases	71	43	34	37		22	10	12	10

*L = lower-division costs, U = upper-division costs, G1 = masters-level costs, G2 = doctorate-level costs, G = combined graduate costs.

1.5 to 1, for upper to lower division; and 3.75 to 1 for graduate to lower division. These ratios are taken as representing differences in costs per credit hour, as measured on a full-cost basis. Actually, her cost data are full operating costs plus capital costs, or more inclusive than the full-cost data in Table 1 which refer to operating costs only. As one can see, some of the data in Table 1 are quite similar to O'Neill's. The combined graduate ratio (G:L) for full costs is just over 4 to 1 (for doctoral and research institutions), compared to her 3.75 to 1. Her 1.5 to 1 ratio for upper to lower division is very close to the average of the full-cost mean values for the various types of institutions in Table 1.

The picture is complicated by the fact that O'Neill's data source for the cost ratios was a set of studies done in Michigan during the 1960's, which provided data on direct costs, not full costs. In noting this, O'Neill suggests that the ratios she uses may be biased upwards, given that indirect costs "are more equitably distributed by grade level" and thus will depress cost ratios when added to direct costs (p. 14). It is difficult to judge from the data in Table 1 whether her concern was as justified in practice as it is in principle. For the most part the data in the table reflect conditions during the 1970s and early 1980s. James (1978) provides evidence that the cost ratios have been getting larger over the past several decades, at least for research universities. It may be, then, that O'Neill's data were upward biased with repect to the analysis she was undertakirg at . time. Those same estimates, however, would be downward biased at the present time, if the broadly based figures in Table 1 are to be believed. And, to complete the picture, the same ratios (3.75:1.5:1) were used in the work done by Skoro and Hryvniak (1980) that extended O'Neill's longitudinal analysis another ten years through 1977. In this instance, the estimated ratios were very much on target

except for comprehensive institutions, where most graduate instruction is at the master's level.

Another important use of cost ratios occurs in Bowen's 1980 work on the costs of higher education. The ratios are used to construct an artificial student unit that in turn is used to derive cost-per-student data. Differences among institutions in costs per student, which Bowen shows to be quite large, are to some extent a function of the ratios adopted. Based on his analysis of some fifteen studies in which costs by level are reported, Bowen uses the following ratios: 1.5 to 1, upper to lower division; 2.1 to 1, masters to lower division; and 3 to 1, for "beyond first year" graduate students to lower division. To compare these ratios with those in Table 1, one must keep in mind that they are for full costs, expressed in per-student rather than per-credit-hour terms, and refer to costs by level of student rather than level of instruction.

It is difficult to determine how best to convert cost ratios based on credit hours to ratios based on students. O'Neill makes no adjustment at all, which surely must result in the cost of doctoral-level students being overestimated, since it is unlikely that they take as many credit hours as the typical undergraduate does. But how large is the proper adjustment? The available data on masters students is ambiguous.

On the one hand, the ratio data gathered as part of this study indicates that little or no adjustment is needed. For instance, at comprehensive institutions the student-based cost ratio was 2.96 for direct costs (26 cases) and 2.27 for full costs (20 cases) compared to 2.8 and 2.59, respectively, in Table 1. At research institutions, the corresponding values were 4.32 (6 cases) and 3.26 (6 cases), compared to 4.05 and 3.22, respectively, in Table 1.

The correspondance was similar for doctoral institutions, but all five cases were from the same state. On the other hand, in two states (Idaho and Wisconsin) where cost ratios are calculated in both per credit hour and per student terms, the per-student ratio for masters to lower division is about 20 to 30 percent below that for the per-credit hour ratio. Data from the Higher Education General Information Surveys (HEGIS), when they still contained data on student credit hours by level, show that the full-time equivalent of first-year graduate students (a reasonable surrogate for a masters student) take about 11.5 credits on average for all types of institutions offering instruction at that level, compared to about 15 credits for undergraduates. This would argue for a 23 percent adjustment, i.e., for multiplying the G1:L values in Table 1 by 11.5/15, or .77, to move from per-credit-hour to per-student ratios.

For doctoral-level instruction, a heavier adjustment is required. For full costs, a figure of 30 percent is not unreasonable, and would put the estimate for doctoral and research universities combined at about 3.1, i.e., .7 times 4.42. For direct costs, if we assume that doctoral students take 8 credits on average, compared to 15 for lower-division students, then the multiplier is .53. It yields an estimated cost ratio of 4.57 at doctoral and research institutions combined.

To adjust the data in Table 1 to reflect cost ratios per student by level of student, the data must first be transformed, in the manner just described, from per-credit-hour to per-student cost ratios. Then the per-student ratios can be converted from level of instruction to level of student by multiplying the per-student ratios by some number that is greater than zero but less than one. Because students at one level occasionally take courses at other levels,

the cost ratios by level of student must be less than the ratios by level of instruction. Gibson (1968), for instance, found differences of 12 percent and 25 percent for upper-division and graduate cost ratios, respectively, between level-of-instruction and level-of-student ratios at a research university. By contrast, across 11 public universities in Ohio in 1983-84 upper-division students took 17 percent of their credit hours at the lower-division level of instruction, while graduate students took only 4.5 percent of their credits at the undergraduate level (Jones, 1985), suggesting rather different adjustment factors than those indicated by Gibson's analysis. No broadly based measures of average behavior in this regard could be assembled. The few available data sources suggest that the patterns differ considerably from one institution or state to the next.

While recent data predominate in the studies included in Table 1, there is enough of a temporal spread in the data to provide confirmation of James (1978) notion that the ratios (per credit hour by level of instruction) have become larger at institutions that are heavily committed to graduate education and research. Comparing the period from 1953 to 1974 to the period from 1978 to 1985, the increases were about 12, 28, and 44 percent, for upper-division, masters, and doctoral cost ratios, respectively, at research universities. At other types of institutions, the ratios have stayed about the same, as measured by the data gathered for this study.

Results by Discipline

There are two primary factors that could be expected to create differences in the costs ratios by discipline. The fundamental factor would be the underlying production relationships that are required (more or less) by the various disciplines. A relatively heavy reliance on laboratory courses, for

instance, would be one such relationship. The need for relatively small classes, as in a writing program, would be another. The second factor is the differing effects of scale. A discipline that is undersubscribed relative to the capacity (mostly in the form of faculty) that must be maintained to assure a quality program is likely to have relatively high costs. There could be some changes in the rankings among disciplines over time, then, in accord with changes in student demand for various programs.

Table 2 shows cost ratios for a selected set of disciplines. The first portion of the table provides ratios for comprehensive institutions that have substantial masters-level programs. The second portion of the table provides data on institutions that are heavily engaged in doctoral-level instruction. Note that all ratios are expressed in per-student-credit-hour terms.

At comprehensive institutions, it is clear that relatively high cost ratios are common in the sciences, both natural and social, comparing upper to lower division as well as masters to lower division. We might speculate, however, that the reasons for this pattern differ for the two types of science. For the natural sciences, it may well be laboratory courses and equipment requirements that drive up the ratios. For the social sciences, it is more likely that we are seeing the effects of having lower-division costs driven down by virtue of the disciplines having a service function in the overall curriculum. That is, many students take lower-division courses in the social sciences in support of their major, or simply as an elective. Enrollments in the lower division soar with large class sizes and low unit costs as a consequence. This phenomenon is less likely to occur in the natural sciences.

Table 2. Cost Ratios by Selected Disciplines

Comprehensive Institutions

Upper Division to Lower Division

	Mean	S.D.	Min	Max	N
Biology	2.26	1.11	1.00	7.34	50
Psychology	2.20	1.16	0.69	7.79	48
Physical Science	2.12	1.19	1.04	7.22	50
Social Science	2.04	0.51	1.38	3.88	50
Mathematics	1.99	0.70	0.60	4.13	50
Letters	1.75	0.48	0.94	2.75	50
Art and Music	1.72	0.50	0.81	3.35	49
Computer Science	1.52	0.78	0.81	4.05	26
Education	1.29	0.48	0.68	3.56	44
Business	1.28	0.32	0.80	2.48	40
Engineering	1.26	0.35	0.29	1.76	14
Group Average	1.74	0.67	0.86	4.13	

Masters to Lower Division

	Mean	S.D.	Min	Max	N
Biology	4.63	2.52	1.27	16.33	42
Physical Science	4.38	2.25	0.88	11.44	42
Psychology	4.35	2.64	1.43	15.40	42
Social Science	4.22	2.03	1.57	12.18	49
Mathematics	4.21	2.37	0.74	11.38	48
Engineering	3.33	3.01	1.49	11.56	8
Computer Science	3.27	2.66	0.70	11.21	13
Letters	3.24	1.54	1.50	9.13	48
Business	3.15	2.08	0.93	14.14	37
Art and Music	3.06	1.83	0.49	10.97	46
Education	1.87	1.35	1.00	10.44	43
Group Average	3.34	1.76	1.25	8.97	

Table 2. Continued

Doctoral and Research Institutions

Upper Division to Lower Division

	Mean	S.D.	Min	Max	N
Biology	2.17	0.62	1.14	3.19	29
Computer Science	2.13	0.73	0.83	3.13	25
Mathematics	2.08	0.60	1.18	4.43	25
Letters	2.05	0.58	1.15	4.00	20
Social Science	2.02	0.48	1.13	3.37	28
Psychology	2.01	0.68	1.22	4.38	29
Physical Science	2.00	0.33	1.31	2.55	29
Art and Music	1.81	0.40	1.25	2.66	27
Business	1.65	0.32	1.17	2.09	31
Engineering	1.54	0.49	0.91	2.28	27
Education	1.19	0.30	0.63	2.20	29
Group Average	1.88	0.50	1.08	3.12	

Masters to Lower Division

	Mean	S.D.	Min	Max	N
Psychology	6.72	2.67	4.17	15.30	23
Physical Science	5.53	1.82	2.80	10.34	30
Biology	5.42	1.48	2.88	11.00	29
Social Science	5.12	1.10	3.20	9.00	28
Mathematics	5.00	1.86	2.40	11.70	24
Letters	4.31	1.20	2.21	6.64	27
Business	4.13	1.35	1.92	8.48	31
Computer Science	3.97	2.06	1.38	7.73	25
Engineering	3.55	1.54	1.62	7.16	27
Art and Music	3.34	0.92	1.94	5.68	28
Education	1.70	0.62	1.02	3.84	29
Group Average	4.44	1.51	2.32	8.81	

Doctoral to Lower Division

	Mean	S.D.	Min	Max	N
Computer Science	13.43	8.88	0.62	24.00	12
Mathematics	12.61	6.25	3.26	25.82	19
Social Science	12.16	3.20	5.23	19.00	22
Psychology	11.29	5.64	3.80	25.46	17
Physical Science	9.70	3.75	2.91	20.53	29
Biology	8.97	3.44	3.71	17.36	22
Letters	8.22	3.92	2.07	12.50	14
Business	7.81	6.10	1.92	22.70	18
Engineering	6.84	2.12	2.41	9.92	27
Education	4.72	1.50	1.94	7.10	22
Art and Music	4.23	1.48	2.00	8.33	15
Group Average	4.23	1.48	2.00	8.33	

Table 3. The Effect of Weighting Enrollment by Estimated Cost Ratios on Expenditure-Per-Student Rankings

Inst'n	--- Unweighted --- Exp's per Student	Index	--- Study Weights* Exp's per Student	Index	Enrollment Ratios U:L	G:L
A	$2,253	106.7	$1,557	116.6	0.69	0.19
B	$2,184	103.4	$1,415	105.9	0.99	0.28
C	$2,168	102.6	$1,302	97.5	0.78	0.44
D	$2,155	102.0	$1,248	93.4	0.99	0.55
E	$2,094	99.1	$1,247	93.3	0.89	0.47
F	$2,033	96.2	$1,293	96.8	1.16	0.19
G	$2,018	95.5	$1,313	98.3	0.89	0.28
H	$1,994	94.4	$1,313	98.3	0.70	0.26
avg	$2,112	100.0	$1,336	100.0	0.89	0.33

*Lower division = 1, upper-division = 1.58, graduate = 3.31.

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Inst'n	Alternate Weights* Exp's per Student	Index	Alternate Weights** Exp's per Student	Index
A	$1,497	116.5	$1,523	117.5
B	$1,355	105.4	$1,378	106.4
C	$1,260	98.1	$1,253	96.7
D	$1,205	93.7	$1,199	92.5
E	$1,204	93.7	$1,200	92.6
F	$1,235	96.1	$1,259	97.1
G	$1,260	98.0	$1,278	98.6
H	$1,266	98.5	$1,276	98.5
avg	$1,285	100.0	$1,296	100.0

*Lower division = 1, upper-division = 1.74, graduate = 3.31.
**Lower division = 1, upper-division = 1.58, graduate = 3.64.

Perhaps the most interesting result for the comprehensive institutions is that costs per credit hour in engineering differ relatively little within the undergraduate years, as measured by the mean or the difference between the minimum and maximum values. What is not indicated by the data in Table 2, but is generally true, is the relatively high cost of engineering programs. What the data here show is that these relatively high costs occur already at the lower-division level--they would have to in order to generate these low cost ratios.

In looking at the results for the doctoral institutions we find that at the undergraduate level there is less volatility in the ranges than at the comprehensive institutions, even though the mean value is higher. This situation is probably due to the influence of the scale of operation. The doctoral institutions have sufficiently large enrollments to make severe diseconomies of scale at the upper-division level quite unlikely. This is less true for the comprehensive institutions.

At the doctoral institutions, there is very little difference from one set of cost ratios to another for the bottom ranked disciplines. Education, for instance, is ranked last or next to last in all three panels, and engineering, art and music, and business also are consistently near the bottom. There is consistency at the high end of the cost ratios as well. Although no discipline ranks in the top four in all three pairings, mathematics, biology, psychology, computer science, physical science, and social science do so in two out of three instances. These results are very similar to those recorded for comprehensive institutions, and they probably reflect similar phenomenon: very low costs at the lower-division level for mathematics and the social sciences,

and relatively high costs at the upper-division level for the laboratory-oriented sciences.

As the standard deviations and ranges indicate, the cost ratios at the graduate level vary considerably among institutions. These differences represent variations in the way programs are configured at the respective institutions, and they should give pause to anyone who would use these figures for normative purposes. Ratios for doctoral-level instruction are especially volitile, no doubt reflecting differences in the kind of program offered (for example, psychology as a social science versus psychology as a laboratory science), differences in scale (which can be significant at the doctoral level even in very large institutions), and differences in the expectations that institutions and departments have for teaching loads, departmental research, and so on.

Effect on Cost-Per-Student Comparisons

One of the important uses of cost-by-level ratios is to control for differences among institutions that might otherwise distort comparative financial data. A case in point are interinstitutional comparisons of costs per student. It should be intuitively obvious on the basis of the data in Tables 1 and 2 that failure to take into account, or control for, the extent of an institution's activity at the various levels of instruction could seriously prejudice any such comparison. In what follows, some actual expenditure and enrollment data are used in conjunction with the cost ratios to demonstrate the effects of failing to control for differences in cost by level of instruction.

Table 3 shows expenditures per student for eight institutions of the same type (fiscal 1980 HEGIS data). In the first column of expenditures in the upper

panel, the figures are derived using unweighted student counts. The next column to the right shows index values based on these expenditures. An index value of 100 is average. In the next column of expenditures, the figures are based on the weights shown in Table 1 for doctoral and research universities combined, adjusted (as shown) for a per-student by level-of-student analysis. (The cost-ratio for graduate students, 3.31, is derived by multiplying 4.78 by .77 by .9. The 4.78 comes from Table 1 for doctoral and research universities combined. The per-credit-hour to per-student adjustment, .77, is based on the fact that for reporting purposes the average number of credits taken by an FTE graduate student is about 11.5, and 11.5 divided by 15, the average number of credits taken by lower-division students, is .77.) The next column to the right shows the index values for the weighted expenditures. As the data plainly show, the cost-per-student indices are affected materially by the weights, even though the set of institutions are generally comparable: they are all large doctoral and research-oriented universities. The reason why is shown in the last two columns in the upper panel. Even though institutional mission and size may be similar, differences in enrollment by level in conjunction with differences in per-student costs by level lead to rather different conclusions about relative costs. Institution D, for instance, starts out with above average costs, and ends up, after the weighting, with costs that are well below average--in fact, they are second lowest in the group.

In the lower panel, the data show the results of increasing the cost ratios by ten percent. The columns on the left show the results of changing the value for U:L; those on the right show the results for changing G:L. The effect on the indices is roughly .1 to .9 percentage points, depending on the institution, with the sensitivity being slightly greater for changes in G:L.

Conclusion

The data on cost by level of instruction suggest that considerable care needs to be exercised in developing and using cost ratios in funding or allocation formulas, in setting differential tuition rates, or in assessing equity in terms of resources allocated to the several levels of instruction. The data in Tables 1 and 2 show what the central tendencies are for these cost ratios at various types of institutions, but they also show how different the ratios can be among institutions of the same general type. These differences and the ratios themselves point to a fundamental aspect of most operating costs in higher education--they depend on what someone decides they will be, as well as being a function of technological imperatives. This fundamental fact does not gainsay, however, the value of knowing what the central tendencies are. The very flexibility of costs, i.e., of resource allocation and utilization, gives significance to data on what actually is done, on average, by various institutions across the nation. The average values are not so much norms as they are benchmarks, or signposts, that point the way to reasonable levels of resource requests, resource allocation, and pricing.

Appendix A

The criteria used in classifying institutions by the categories shown in Tables 1-5 are as follows:

Research Universities

These institutions are characterized by a significant level of activity in and commitment to doctoral-level education as measured by the number of doctorate recipients and the diversity in doctoral program offerings and by a significant level of research activities. To be classified as a research university, an institution must grant a minimum of 30 doctoral-level degrees in three or more doctoral-level program areas[1] on an annual basis or, alternatively, have an interdisciplinary program at the doctorate level. Included in the counts of doctorate degrees are the first professional degrees (M.D., D.D., D.V.M., D.D.S.). In addition to meeting the criteria on degrees, a research university must rank among the top 75 institutions in the country in research expenditures. For this study, exceptions have been made to include Rockefeller University and Georgia Institute of Technology Main Campus in this category because of their doctoral program emphasis and substantial level of research.

Universities

These institutions meet all of the criteria stated above, except they are not as extensively involved in research activities as the research universities.

[1]Programs or program areas are a major field of study as defined at the two-digit level of the HEGIS Taxonomy of Programs.

Comprehensive Institutions

These institutions are characterized by a strong, diverse postbaccalaureate program (including first professional) but do not engage in significant doctoral-level education. Specifically, this category includes institutions not considered major doctoral schools in that the number of doctoral-level degrees granted is less than 30 or in that fewer than three doctoral-level programs are offered. In addition, these institutions must grant a minimum of 30 postbaccalaureate[2] degrees and either grant degrees in three or more postbaccalaureate programs, or alternatively, have an interdisciplinary program at the postbaccalaureate level.

General Baccalaureate Institutions

These institutions have, as their primary emphasis, general undergraduate, baccalaureate education. They are not significantly engaged in postbaccalaureate education. Included are institutions not considered specialized institutions, in which the number of postbaccalaureate degrees granted is less than 30 or in which fewer than three postbaccalaureate level programs are offered, but either (a) grant baccalaureate degrees and grant degrees in three or more baccalaureate programs, or (b) offer a baccalaureate program in interdisciplinary studies. Additionally, over 25 percent of the degrees granted must be at the baccalaureate level or above.

[2]Includes master's, doctoral, and first-professional degrees.

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